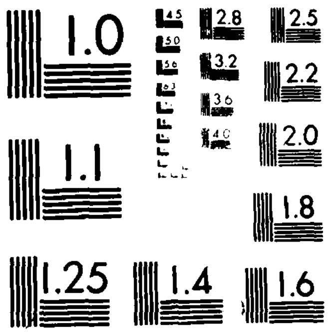
AD-A171 869   THE SOLAR PROTON EVENT OF 16 FEBRUARY 1984:   1/1
OBSERVATIONS AT LOW ALTITUDE..(U) AEROSPACE CORP EL
SEGUNDO CA SPACE SCIENCES LAB J B BLAKE ET AL.
UNCLASSIFIED 01 AUG 86 TR-0086(6940-05)-8 SD-TR-86-51   F/G 4/1   NL



MICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS 1963-A

(12)

REPORT SD-TR-86-51

AD-A171 869

The Solar Proton Event of 16 February 1984: Observations at Low Altitude Over the Earth's Polar Caps

J. B. BLAKE and W. A. KOLASINSKI
Space Sciences Laboratory
Laboratory Operations
The Aerospace Corporation
El Segundo, CA 90245

DTIC
ELECTE
SEP 1 5 1986
S D
D

1 August 1986

APPROVED FOR PUBLIC RELEASE;
DISTRIBUTION UNLIMITED

Prepared for

SPACE DIVISION
AIR FORCE SYSTEMS COMMAND
Los Angeles Air Force Station
P.O. Box 92960, Worldway Postal Center
Los Angeles, CA 90009-2960

DTIC FILE COPY

86 9 15 095

This report was submitted by The Aerospace Corporation, El Segundo, CA 90245, under Contract No. F04701-85-C-0086 with the Space Division, P.O. Box 92960, Worldway Postal Center, Los Angeles, CA 90009-2960. It was reviewed and approved for The Aerospace Corporation by H. R. Rugge, Director, Space Sciences Laboratory.

Capt Douglas R. Case/YCM was the project officer for the Mission-Oriented Investigation and Experimentation (MOIE) Program.

This report has been reviewed by the Public Affairs Office (PAS) and is releasable to the National Technical Information Service (NTIS). At NTIS, it will be available to the general public, including foreign nationals.

This technical report has been reviewed and is approved for publication. Publication of this report does not constitute Air Force approval of the report's findings or conclusions. It is published only for the exchange and stimulation of ideas.

Douglas R. Case

DOUGLAS R. CASE, Capt, USAF
MOIE Project Officer
SD/YCM

Joseph Hess

JOSEPH HESS, GM-15
Director, AFSTC West Coast Office
AFSTC/WCO OL-AB

UNCLASSIFIED

SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

REPORT DOCUMENTATION PAGE

READ INSTRUCTIONS BEFORE COMPLETING FORM

1. REPORT NUMBER SD-TR-86-51	2. GOVT ACCESSION NO. A171 869	3. RECIPIENT'S CATALOG NUMBER
4. TITLE (and Subtitle) THE SOLAR PROTON EVENT OF 16 FEBRUARY 1984: OBSERVATIONS AT LOW ALTITUDE OVER THE EARTH'S POLAR CAPS		5. TYPE OF REPORT & PERIOD COVERED 6. PERFORMING ORG. REPORT NUMBER TR-0086(6940-05)-8
7. AUTHOR(s) J. Bernard Blake and Wojciech A. Kolasinski		8. CONTRACT OR GRANT NUMBER(s) F04701-85-C-0086
9. PERFORMING ORGANIZATION NAME AND ADDRESS The Aerospace Corporation El Segundo, CA 90245		10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS
11. CONTROLLING OFFICE NAME AND ADDRESS Space Division Los Angeles Air Force Station Los Angeles, CA 90009-2960		12. REPORT DATE 1 August 1986 13. NUMBER OF PAGES 17
14. MONITORING AGENCY NAME & ADDRESS(If different from Controlling Office)		15. SECURITY CLASS. (of this report) Unclassified 15a. DECLASSIFICATION/DOWNGRADING SCHEDULE

16. DISTRIBUTION STATEMENT (of this Report)

Approved for public release; distribution unlimited.

17. DISTRIBUTION STATEMENT (of the abstract entered in Block 20, if different from Report)

18. SUPPLEMENTARY NOTES

19. KEY WORDS (Continue on reverse side if necessary and identify by block number)

Solar Protons
Polar Cap Observations
16 February 1984

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

This report briefly describes the solar proton intensities as a function of time over the Earth's Polar Caps as observed in the veto counters of the Space Sciences Laboratory x-ray image during the event of 16 February 1984. This event is particularly interesting because the large anisotropy of the proton fluxes in the interplanetary medium caused substantial intensity variations in the fluxes at low altitudes over the Polar Caps.

CONTENTS

QUALITY INSPECTED 3

Accesion For	
NTIS CRA&I	☑
DTIC TAB	☐
Unannounced	☐
Justification	
By	
Distribution /	
Availability Codes	
Dist	Avail and / or Special
A-1	

FIGURES

INTRODUCTION

Low-altitude polar orbiters were used extensively during the early years of the study of energetic particles emitted by the Sun. For many research purposes polar orbiters are much less desirable platforms than satellites located outside of the magnetosphere because the data coverage is only of the order of 30% - the time spent in the polar regions. However, polar orbiters do permit study of the configuration of the magnetosphere. Solar particles, as they move from the interplanetary medium to low altitude over the earth's polar caps, serve as probes of the distant geomagnetic field configuration and its connection with the interplanetary field. This area of research was reviewed by Morfill and Scholer (1973) and Scholer (1975).

It happens that interplanetary field-aligned anisotropies lead to latitudinal intensity variations in polar-cap particle fluxes (Morfill and Scholer, 1975). Unfortunately for such studies solar-particle angular distributions in the vicinity of the Earth are frequently isotropic or nearly so. However the 16 February 1984 solar particle event was very interesting in this regard, because the interplanetary fluxes were strongly anisotropic and remained so throughout the intense part of the event (Bieber et al., 1985). As a result, the polar-cap fluxes showed substantial latitudinal structure.

In this report observations of the solar particle intensity structure are presented as seen by the Space Sciences Laboratory X-ray imager flown aboard the DMSP-F6 satellite.

SATELLITE AND INSTRUMENTATION

The DMSP-F6 satellite was in a near-polar ($i=99°$) orbit at an altitude of ~ 840 km. Continuous data were acquired from the X-ray imager; all polar cap traversals during the event are available.

The X-ray imager had as its prime mission study of auroral morphology on a global scale by observation of the bremsstrahlung resulting from auroral electrons striking the upper atmosphere. The imager was described by Mizera et al. (1985), and in much more detail in a report by Kolasinski and Mizera (1984).

Part of the sensor complement consisted of three CdTe detectors, surrounded over the upper hemisphere by plastic scintillators viewed by photomultiplier tubes. The purpose of the scintillator/photomultiplier assemblies (SPAs) was to allow vetoing of penetrating particles such as galactic cosmic rays.

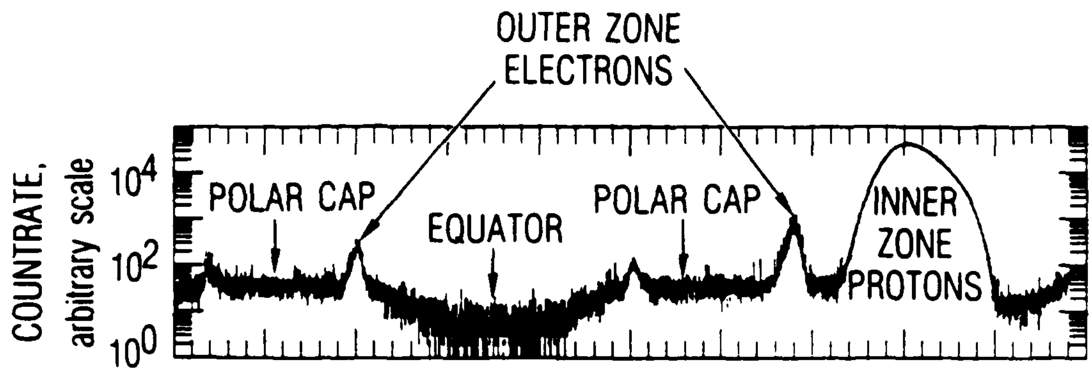
The geometric factor and energy threshold of the SPAs are broad because of the irregular configuration of the scintillators and surrounding instrument mass. In addition, the imager was mounted on the earthward side of the satellite which is three-axis stabilized; thus there was massive and irregular shielding in the zenith hemisphere. Finally the SPAs were part of a scanning system and thus their aspect with respect to the geomagnetic field varied. The SPAs were sensitive to penetrating electrons, to bremsstrahlung generated by radiation-belt electrons striking the instrument and the satellite, to trapped energetic protons, and to solar and galactic particles. Therefore the response of the SPAs on-orbit was complex and to a large degree indeterminate. However, by studying the response of the other detectors comprising the imager system, it is possible to determine where the SPA response was dominated by solar particles and to determine the solar particle cutoff. Such a study would take a significant amount of effort and has not been done for this report.

OBSERVATIONS

Data from a single SPA for an entire orbit prior to the onset of the solar particle event at Earth on 16 February 1984 is shown in Figure 1. The fine structure in the countrate, especially noticeable in the outer-zone electron peak centered at 32236 sec, is due to the scanning motion of the detector head containing the SPA. In Figure 1 the dominant contributors to the SPA countrate are the outer-zone trapped electrons, inner-zone trapped protons, or galactic cosmic rays, depending upon the orbital position of the satellite. Various locations are labeled in the plot. This plot clearly illustrates the lack of selectivity in the SPA response which was discussed above. Note that the two polar plateaus are featureless except for the fine structure due to statistics and the scanning motion, and that they show the same average countrate. In the time interval between 29640 sec and 31100 sec the latitudinal dependence of the countrate due to galactic cosmic rays can be seen. These data show directly the geomagnetic cutoff, for the galactic cosmic rays.

The SPA data from repeated polar-cap traverses of the DMSP-F6 satellite are shown in Figs. 2-8 for the time interval between 28000 sec UT to 84500 sec UT. This time interval covers the period of relatively high proton fluxes at the Earth determined from GOES-6 data. In Figs. 2-8, the average countrates in 10 sec intervals are plotted as a function of invariant latitude, Λ ($\equiv$ arccos $1/\sqrt{L}$).

Plots of data subsequent to the particle-event onset (Figs. 2-8) show substantial latitudinal structure. The fluxes over the two polar caps differ markedly from each other, and the latitudinal structure was time dependent. Note that the countrate due to outer zone electrons "rides" on top of the



UT (sec)	28033	29269	30505	31741	32977
LAT (deg)	40.94	64.01	−8.03	−77.65	−25.72
LON (deg)	329.99	170.75	146.05	97.54	321.20
hr min sec	84712	80748	82824	84900	90936

Fig. 1. An Entire Orbit of Data from an SPA Just Prior to the First Appearance of the Solar Particles. The "spiky" character of the data at times is only partly due to statistical fluctuations; the scanning motion of the SPA causes countrate variations.

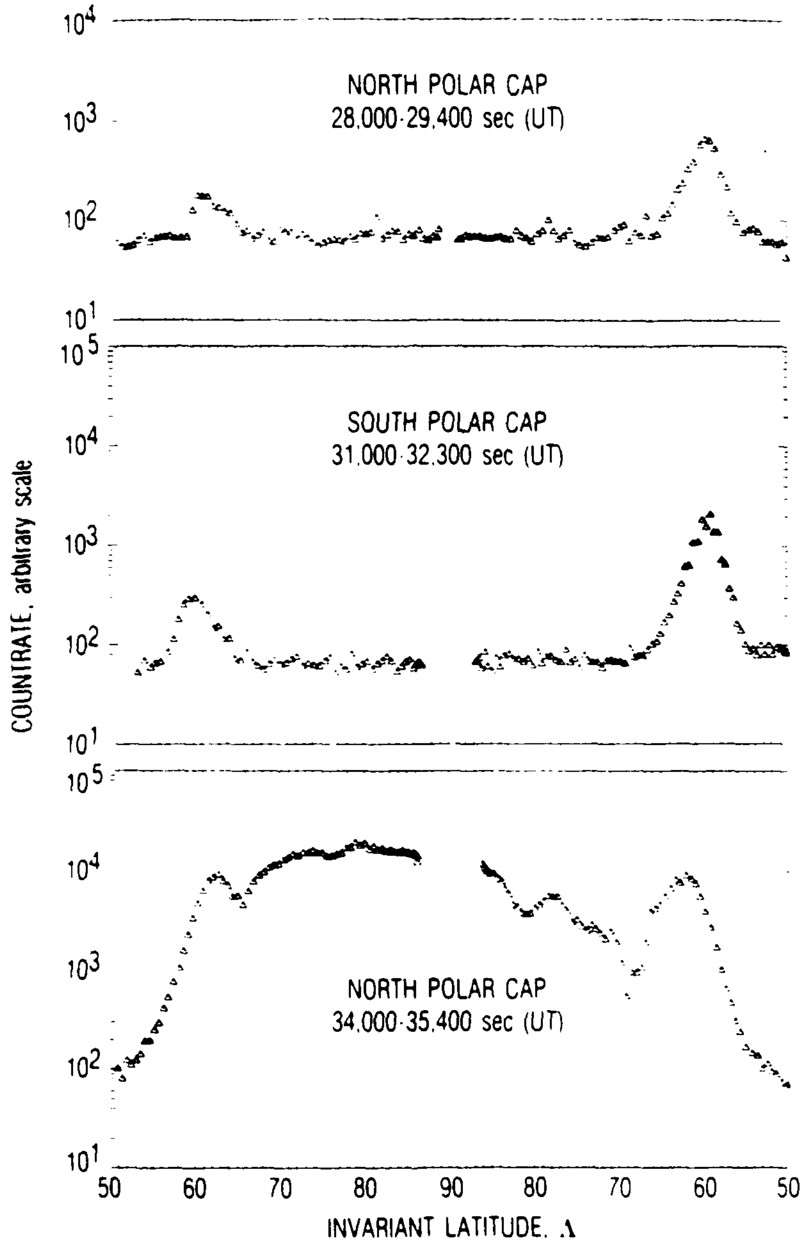


Fig. 2. Three Polar Cap Passes Plotted for Times Between 28,000 sec (UT) and 35,400 sec (UT). The countrate is plotted as a function of invariant latitude ($\equiv$ arccos $1/\sqrt{L}$). A gap near 90° arises because the satellite does not cross directly over the magnetic poles.

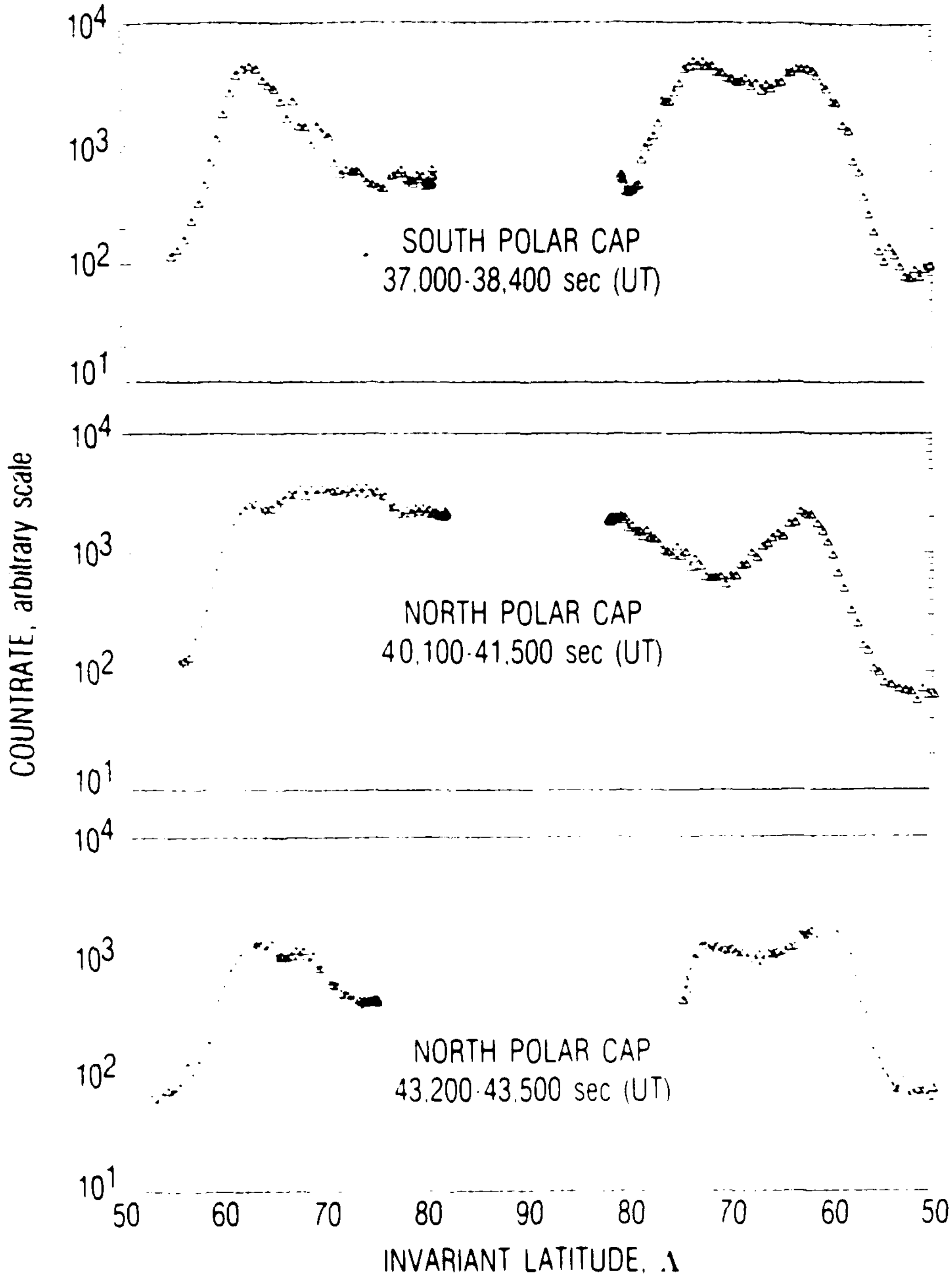


Fig. 3. Same as Fig. 2 for the Time Period from 37,000 sec (UT) to 43,500 sec (UT)

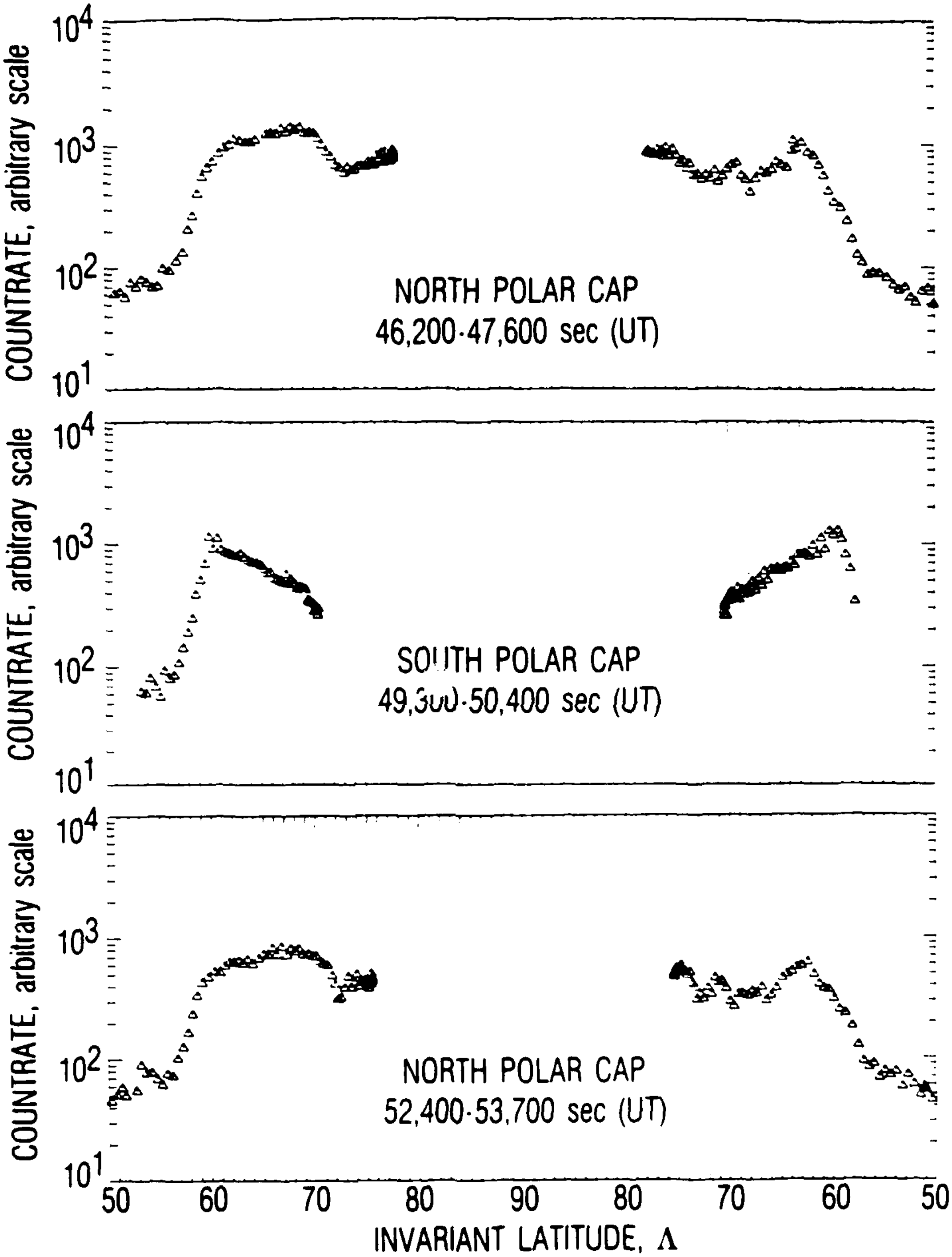


Fig. 4. Same as Fig. 2 for the Time Period from 46,200 sec (UT) to 53,700 sec (UT)

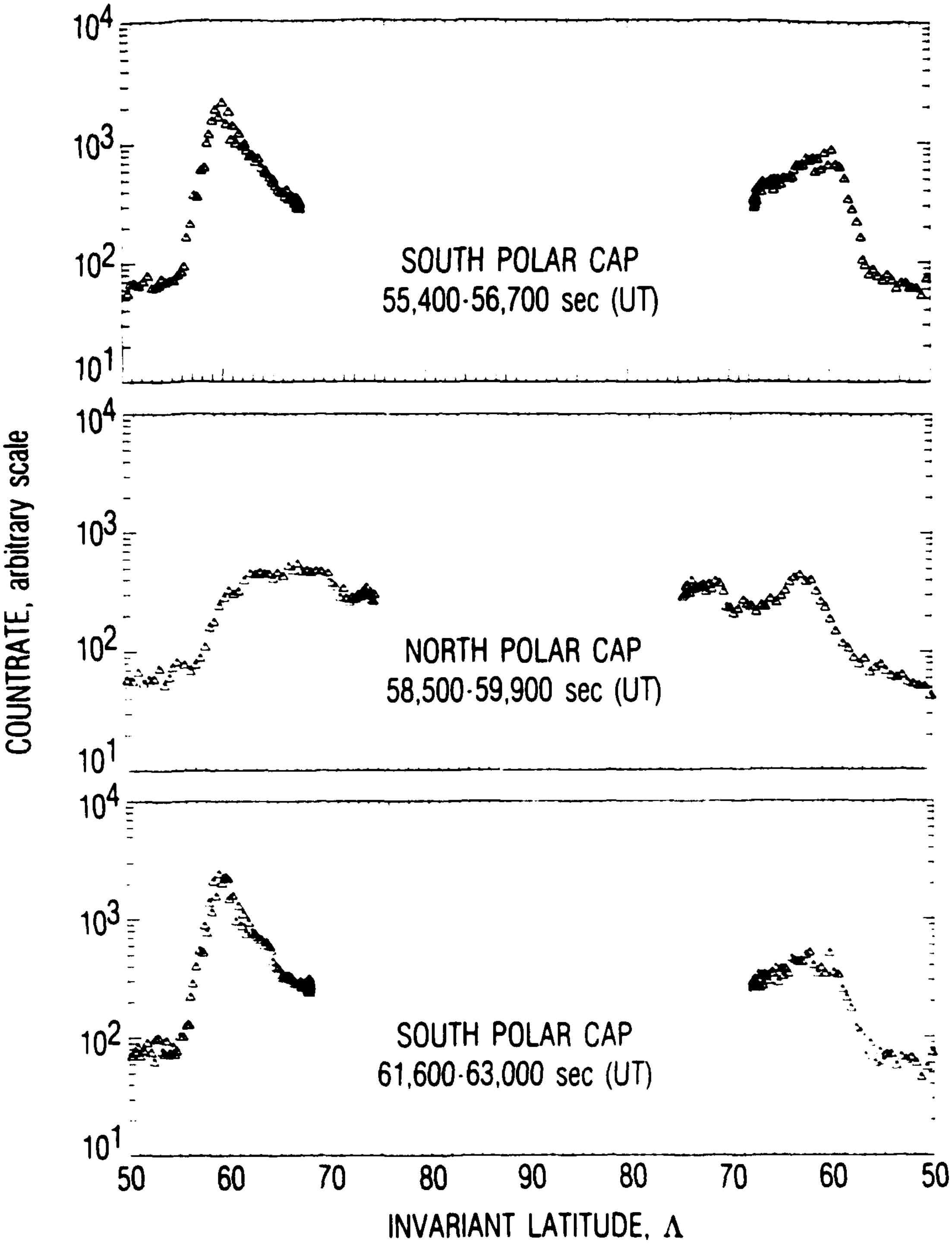


Fig. 5. Same as Fig. 2 for the Time Period from 55,400 sec (UT) to 63,000 sec (UT)

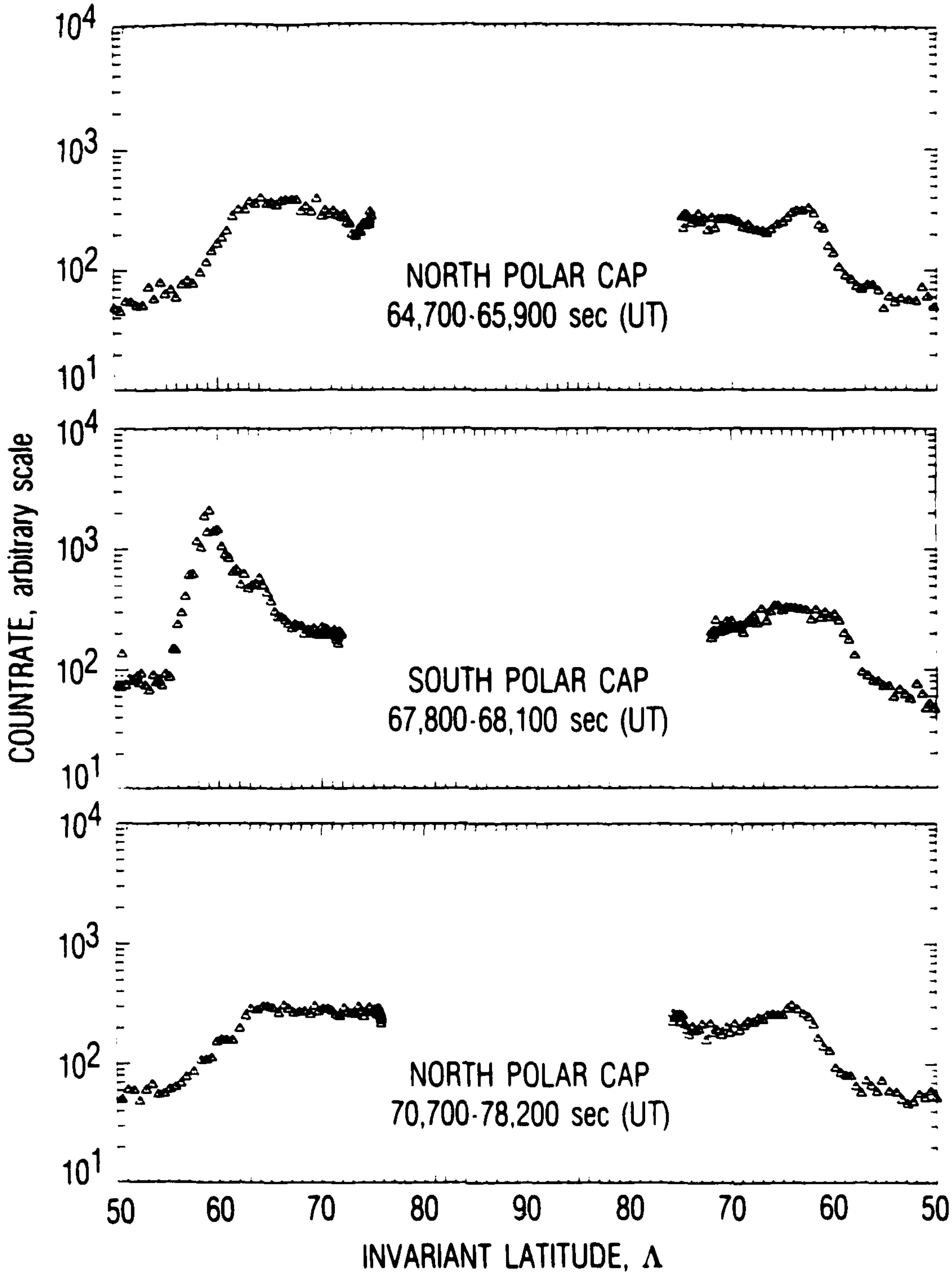


Fig. 6. Same as Fig. 2 for the Time Period from 64,700 sec (UT) to 78,200 sec (UT)

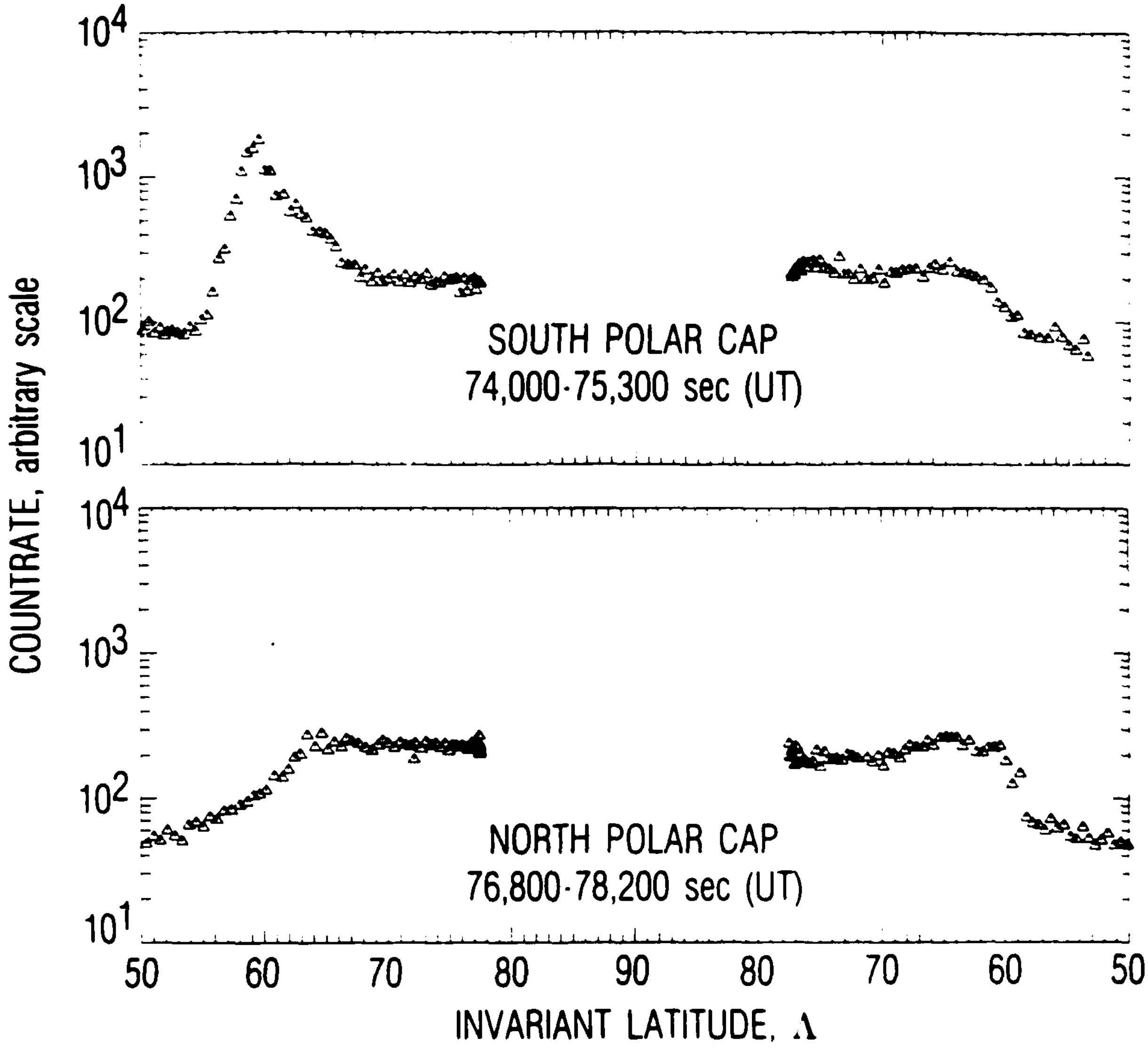


Fig. 7. Same as Fig. 2 for the Time Period from 74,000 sec (UT) to 78,200 sec (UT)

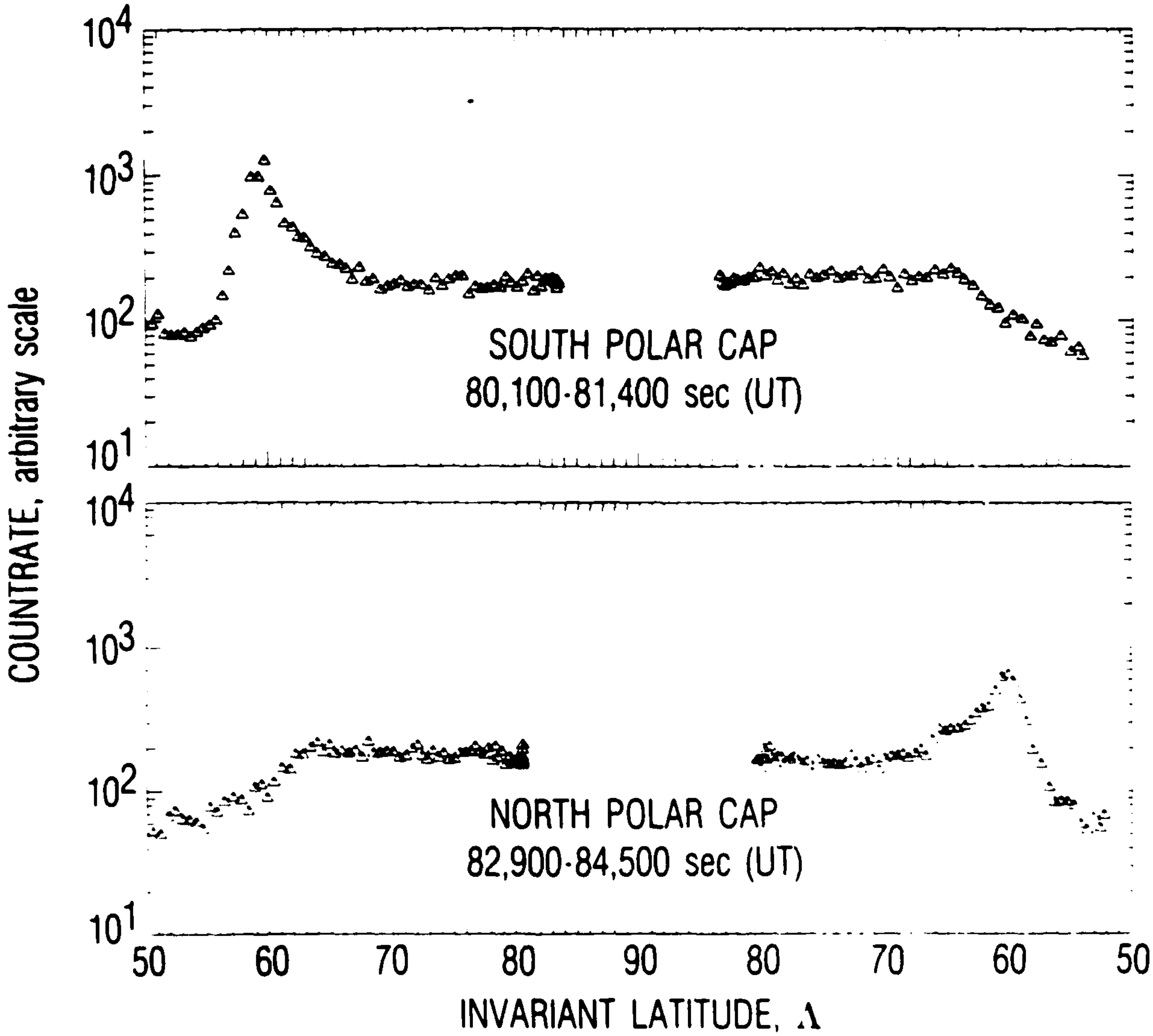


Fig. 8. Same as Fig. 2 for the Time Period from 80,100 sec (UT) to 84,500 sec (UT)

countrate due to the solar particles. The solar particle cutoff is below 60° whereas the electron peak is around 62°. The evolution of the polar cap profile as the day progressed, from highly structured to featureless, can be seen clearly.

The authors would be happy to supply further and more detailed data on this event upon request.

REFERENCES

Bieher, J. W., P. A. Evenson and M. A. Pomerantz, in Proceedings of the 19th International Cosmic Ray Conference, La Jolla, 4, 335, 1985.

Kolasinski, W. A. and P. F. Mizera, Aerospace Corporation Report SD-TR-84-82, 1984.

Mizera, P. F., D. J. Gorney and J. L. Roeder, J. Spacecraft and Rockets, in press, 1985.

Morfill, G. and M. Scholer, Sp. Sci. Rev., 15, 267, 1973.

Scholer, M., Sp. Sci. Rev., 17, 3, 1975.

LABORATORY OPERATIONS

The Aerospace Corporation functions as an "architect-engineer" for national security projects, specializing in advanced military space systems. Providing research support, the corporation's Laboratory Operations conducts experimental and theoretical investigations that focus on the application of scientific and technical advances to such systems. Vital to the success of these investigations is the technical staff's wide-ranging expertise and its ability to stay current with new developments. This expertise is enhanced by a research program aimed at dealing with the many problems associated with rapidly evolving space systems. Contributing their capabilities to the research effort are these individual laboratories:

Aerophysics Laboratory: Launch vehicle and reentry fluid mechanics, heat transfer and flight dynamics; chemical and electric propulsion, propellant chemistry, chemical dynamics, environmental chemistry, trace detection; spacecraft structural mechanics, contamination, thermal and structural control; high temperature thermomechanics, gas kinetics and radiation; cw and pulsed chemical and excimer laser development including chemical kinetics, spectroscopy, optical resonators, beam control, atmospheric propagation, laser effects and countermeasures.

Chemistry and Physics Laboratory: Atmospheric chemical reactions, atmospheric optics, light scattering, state-specific chemical reactions and radiative signatures of missile plumes, sensor out-of-field-of-view rejection, applied laser spectroscopy, laser chemistry, laser optoelectronics, solar cell physics, battery electrochemistry, space vacuum and radiation effects on materials, lubrication and surface phenomena, thermionic emission, photosensitive materials and detectors, atomic frequency standards, and environmental chemistry.

Computer Science Laboratory: Program verification, program translation, performance-sensitive system design, distributed architectures for spaceborne computers, fault-tolerant computer systems, artificial intelligence, microelectronics applications, communication protocols, and computer security.

Electronics Research Laboratory: Microelectronics, solid-state device physics, compound semiconductors, radiation hardening; electro-optics, quantum electronics, solid-state lasers, optical propagation and communications; microwave semiconductor devices, microwave/millimeter wave measurements, diagnostics and radiometry, microwave/millimeter wave thermionic devices; atomic time and frequency standards; antennas, rf systems, electromagnetic propagation phenomena, space communication systems.

Materials Sciences Laboratory: Development of new materials: metals, alloys, ceramics, polymers and their composites, and new forms of carbon; nondestructive evaluation, component failure analysis and reliability; fracture mechanics and stress corrosion; analysis and evaluation of materials at cryogenic and elevated temperatures as well as in space and enemy-induced environments.

Space Sciences Laboratory: Magnetospheric, auroral and cosmic ray physics, wave-particle interactions, magnetospheric plasma waves; atmospheric and ionospheric physics, density and composition of the upper atmosphere, remote sensing using atmospheric radiation; solar physics, infrared astronomy, infrared signature analysis; effects of solar activity, magnetic storms and nuclear explosions on the earth's atmosphere, ionosphere and magnetosphere; effects of electromagnetic and particulate radiations on space systems; space instrumentation.

...

END
10-86
DTIC